DUKE ENERGY SOUTH CAROLINA GRID IMPROVEMENT INITIATIVE WORKSHOP

National Context of Grid Modernization

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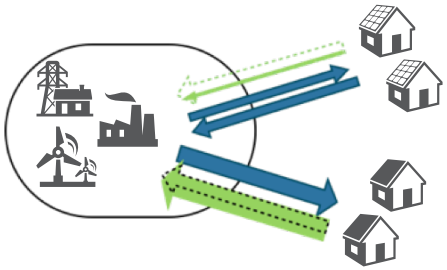
The technological and economic factors underlying today's electricity grid are changing rapidly nationwide

	Old Reality	New Reality
Supply	Large, centralized generation resources provide least-cost energy	A growing array of distributed energy resources (DERs) can provide energy and additional value to the grid
Delivery	The distribution grid is optimized for one-way flow of power, information, and value	Emerging distributed generation technologies create need for two-way flows
Demand	Customer load is projected to continuously grow, and considered uncontrollable	Load growth is flat, but increasingly dynamic



These changes coincide with evolving demands placed on the grid by customers, regulators, and other stakeholders

Resilience

New Load Types

Greenhouse Gas Emissions

Evolving Demands on the Grid

Operational Efficiency

Transparency

Investment Efficacy

“Grid modernization” across the US is defined broadly to include a wide range of approaches to meeting these new demands

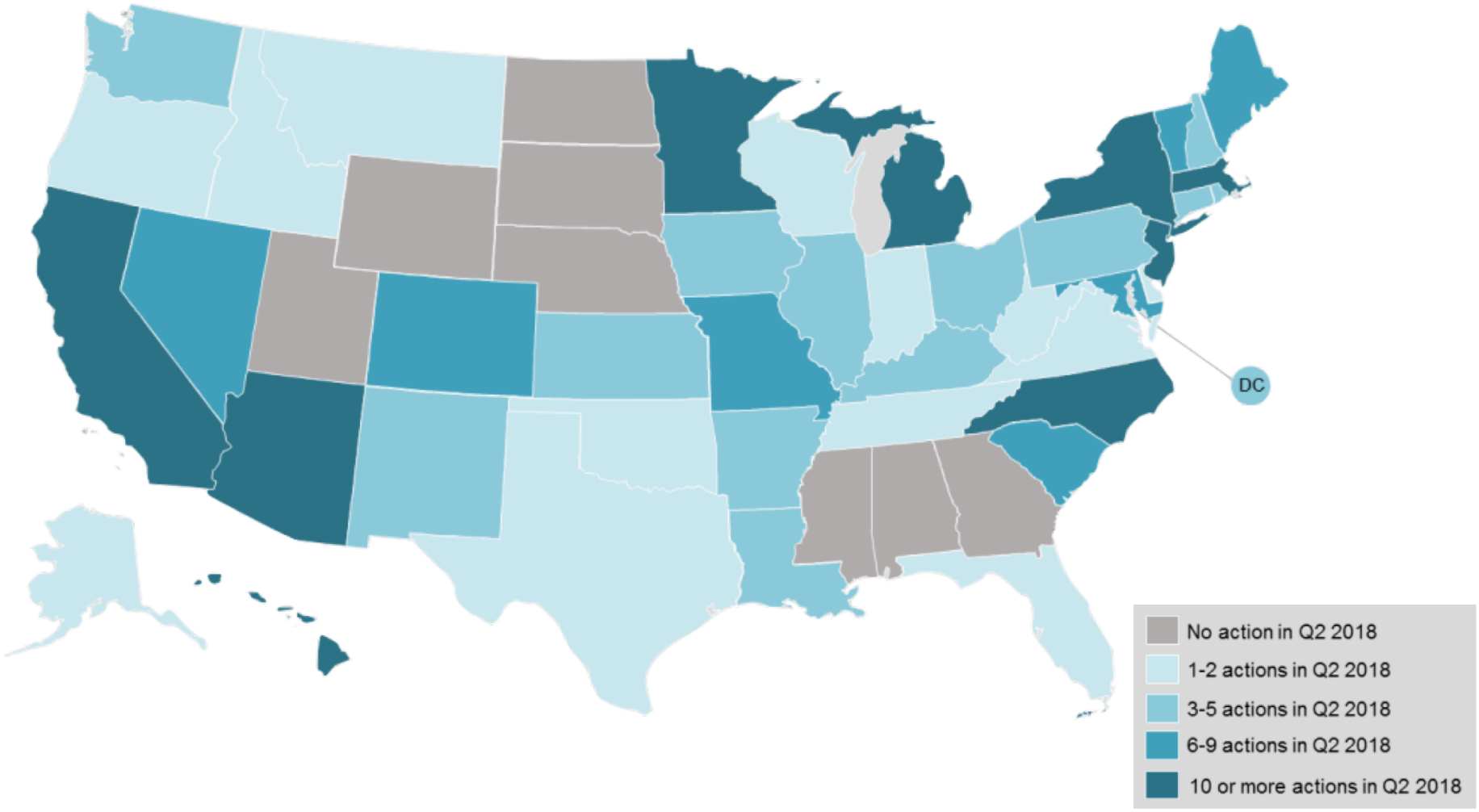
Definition elements from nationally-focused research organizations:

- “**a holistic strategy”** – investments, business practices, regulatory reform
- **“highly context dependent**” – depends on the system in question

Investment strategies	Regulatory reforms and other activities
• Grid sensing, control, and coordination technologies • Energy storage • Hosting capacity / capability • Hardening, resilience, security • Customer-facing data systems	• Rate design • Business model updates • Other regulatory reforms

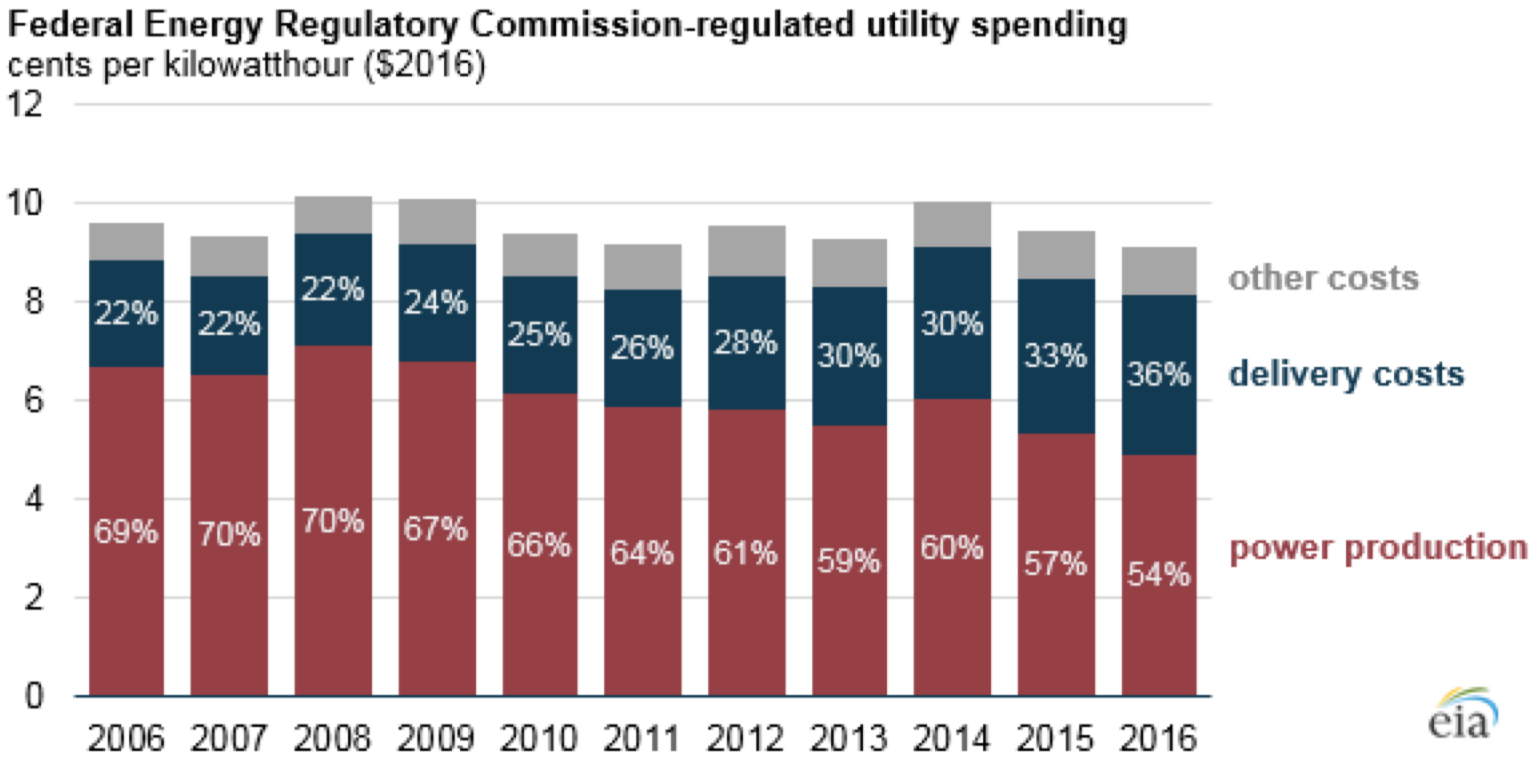
States are proceeding at varying paces of grid modernization

Number of grid modernization actions taken by states in Q2 2018



Source: NCCETC, The 50 States of Grid Modernization: Q2 2018

Investments in the grid, including grid modernization efforts, have led to increased costs for energy delivery



- Average retail electricity prices have stayed stable since 2006, while T&D costs have increased by >50%
- No clear data on how much has been driven by “modernization” versus either routine or cyclical spending

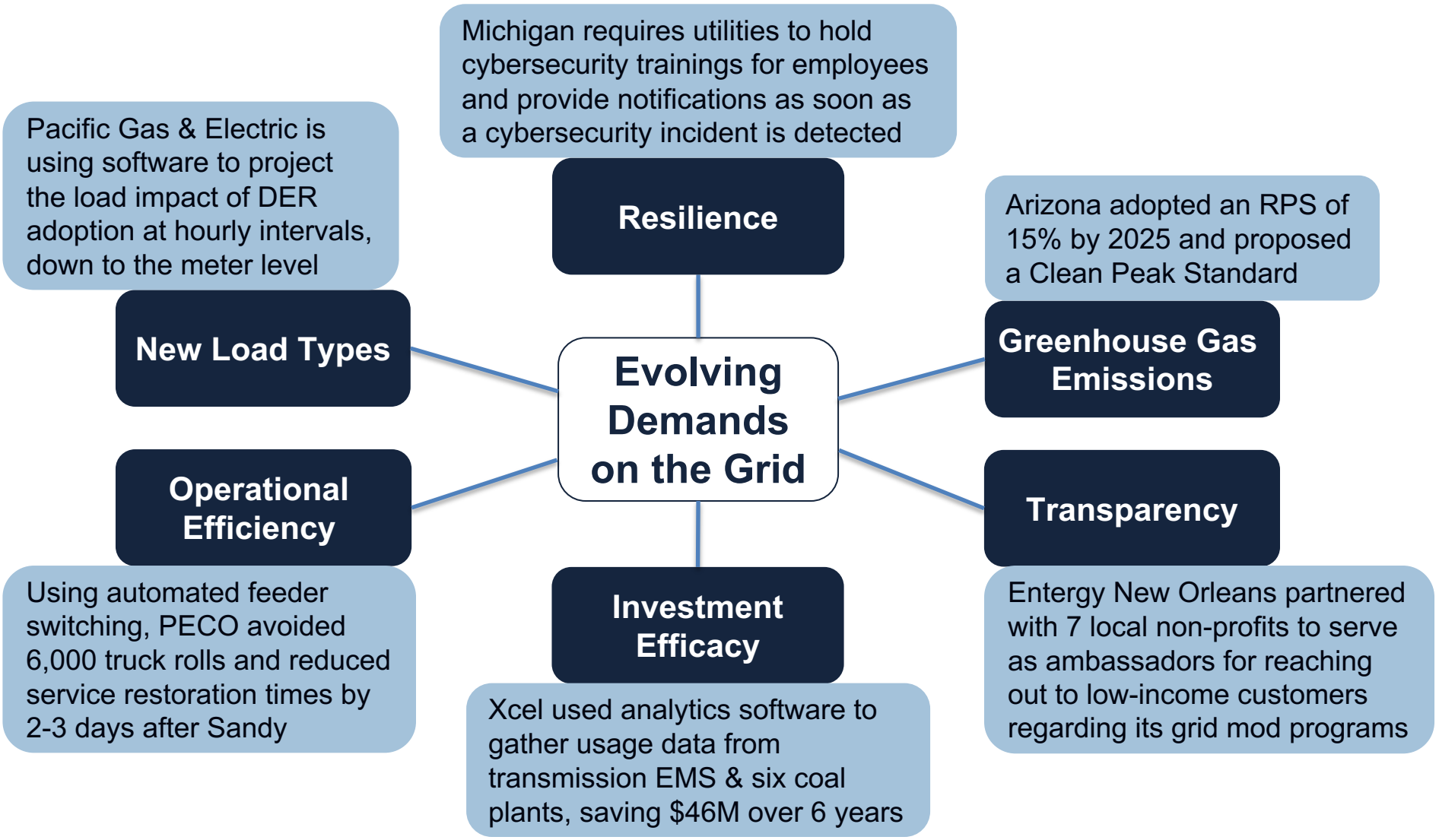
Source: https://www.eia.gov/todayinenergy/detail.php?id=32812

Grid modernization processes face common tradeoffs between competing priorities, creating an opportunity for collaboration

Differing outcomes prioritized	Common tradeoffs	Collaboration opportunity
• Rate stability • Reliability • Resilience • Economic development • Market animation • New technology deployment • Environmental benefits	• Cost vs. benefit • Short- vs. long-term costs and benefit • Who pays and who benefits • Speed versus inclusion • ”Input” versus “feedback” engagement	• Visibility • Shared understanding • Building trust between individuals and organizations • Find multiple benefits of a shared vision

THANK YOU

Utilities have met these growing demands through various approaches



Individual state statutes and regulatory bodies have defined grid modernization in a wide variety of ways

Grid Modernization is…

"Grid modernization refers **to computer-based control and automation technology** to bring current utility electricity delivery systems into the 21st century."

-- Hawaii State Energy Office

(i) "enhancing the **reliability** of the electrical grid;

(ii) improving the **security** of the electrical grid against cyber threats and physical threats;

(iii) increasing energy **conservation** opportunities by facilitating communication between the utility and its customers"

-- Minnesota Statute § 116C.779(k)

(1) "reducing the effects of outages;

(2) optimizing demand, which includes reducing system and customer costs;

(3) integrating **distributed resources**;

(4) improving workforce and asset management."

-- Massachusetts Dept. of Public Utilities 12-76-B

Across the US, different elements of grid modernization are prioritized depending on circumstances

Different terms of definition from nationally-focused organizations

"We define grid modernization broadly, including: **new technology, infrastructure deployment; reforms to policy and regulatory structure; improved planning procedures;** as well as **updates to rate design and utility business models**. "

-- NC Clean Energy Technology Center

"Grid modernization is the overlay of **communication and control/coordination technologies onto the electromechanical grid,** and appropriate investments are highly context dependent."

-- Pacific Northwest National Lab

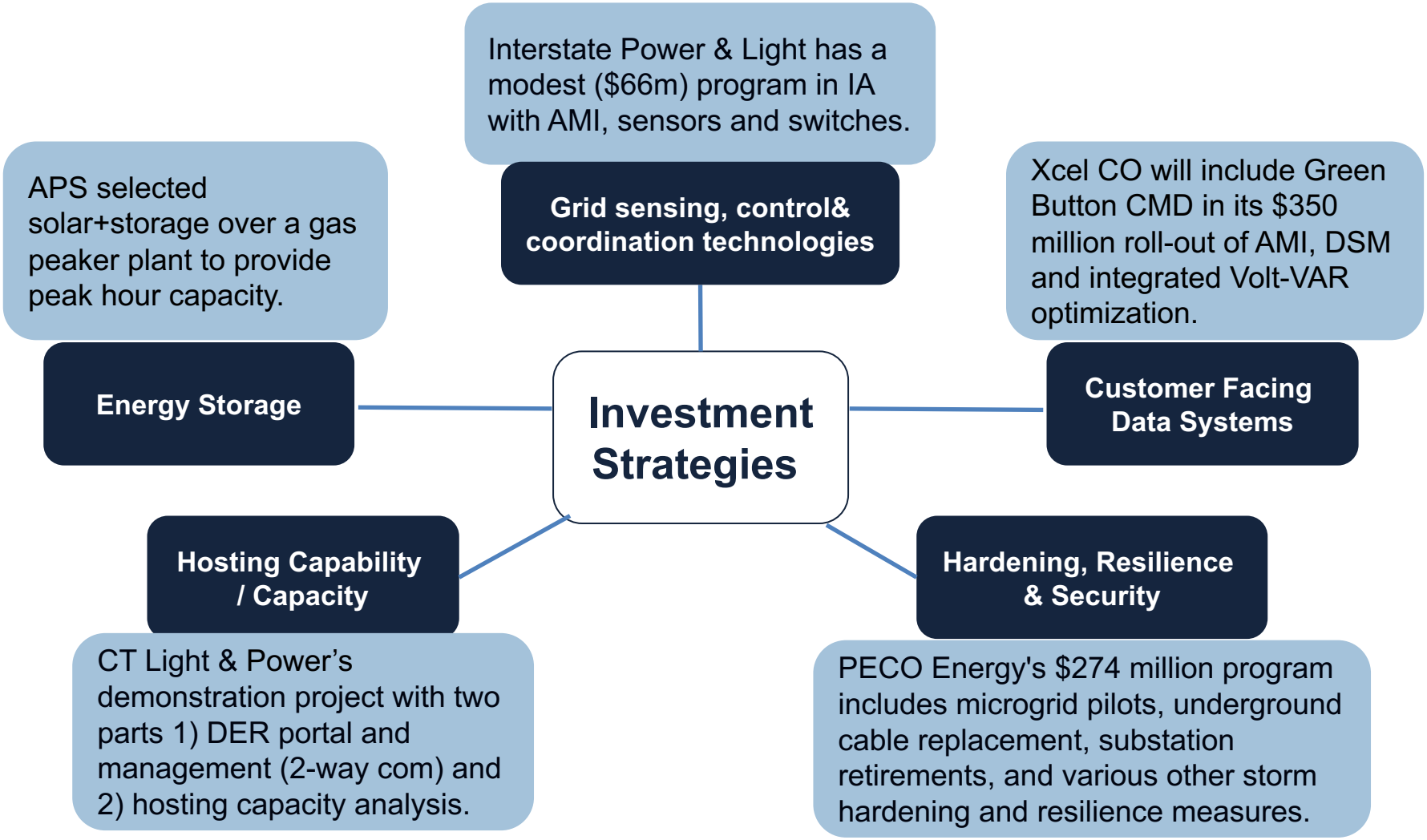
Despite different definitions, there is wide agreement regarding the attributes and functionality a modernized grid should have

"Grid modernization is a holistic strategy to accomplish all of the following: more efficient use of capital along with higher asset utilization; enhanced reliability, resilience and security; greater levels of energy efficiency; improved operational efficiency; and reducing GHG emissions."

-- GridWise Alliance

Source: RMI expert interviews

Grid modernization efforts are composed of a wide variety of activities, including capital investment strategies



Massachusetts: A state-led process defining grid modernization goals to guide utility investments

Overview of Process

Commission orders grid-mod investigation, soliciting stakeholder feedback through workshops

Utilities required to submit 5-year Grid Mod Plans (GMP) that outline plans & investments

Stakeholder suggestions for improvement:

- More rigorous cost-benefit analysis
- More detailed project plans
- Include distributed resources in addition to centralized grid improvements

Source: http://170.63.40.34/DPU/FileRoomAPI/api/Attachments/Get/?path=12-76%2fOrder_1276B.pdf

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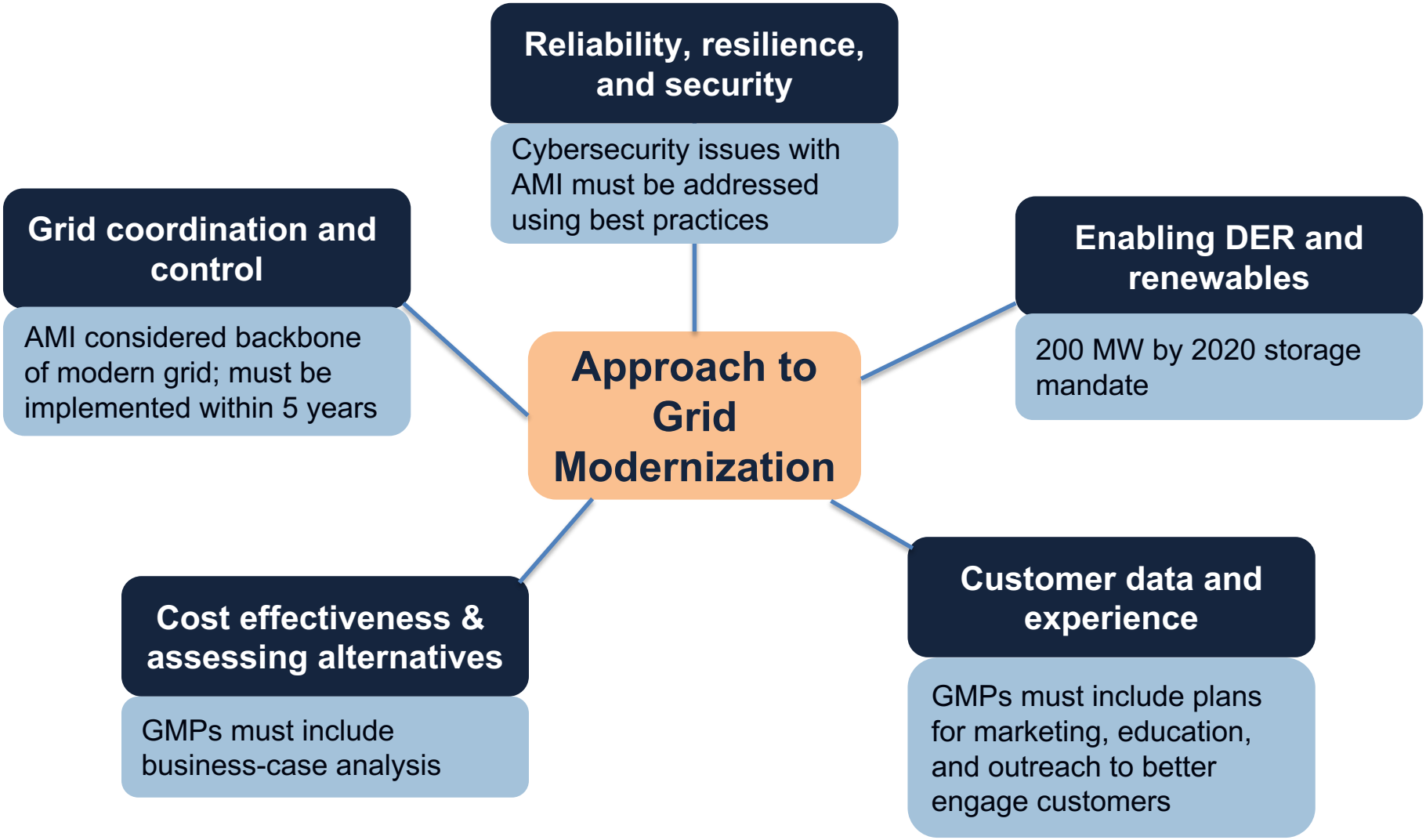

Hawaii: Utility proposals required to address unique state renewable portfolio standards

Overview of Process

Commission orders utilities to develop comprehensive grid-mod strategy for stakeholder review

Initial utility plans were rejected due to cost concerns and insufficient integration of renewables

Final proposal approved for addressing state portfolio standards:*

- 70% renewable by 2030
- 100% renewable by 2045

* Hawaii's grid has uniquely high DER penetration (26%), due to high costs of diesel generation

https://www.hawaiianelectric.com/Documents/about_us/investing_in_the_future/final_august_2017_grid_modernization_strategy.pdf

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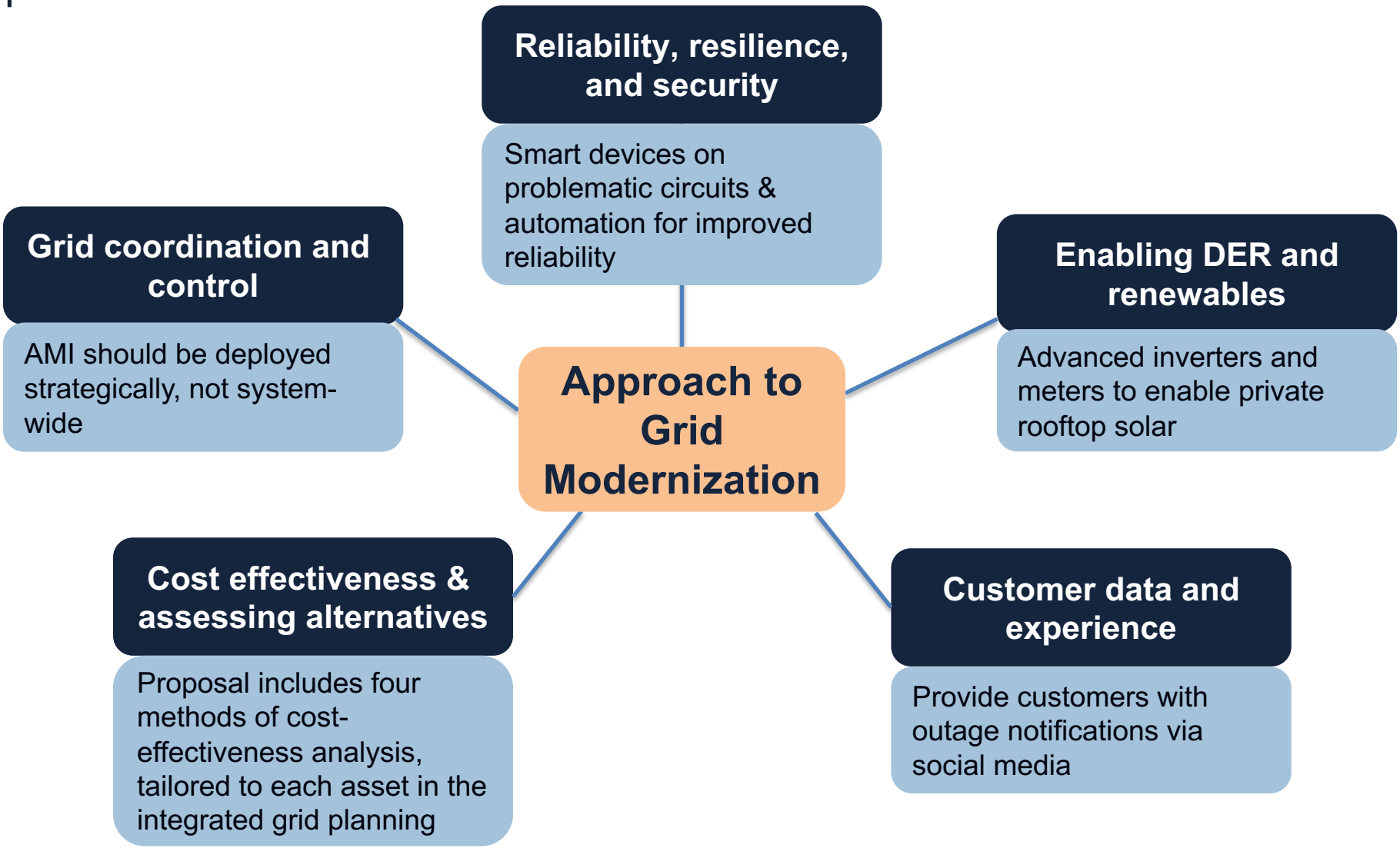

Maryland: Ongoing process focused on enabling DERs and expanding customer choice

Overview of Process

Commission used Exelon-Pepco merger to initiate proceeding to explore grid modernization

In parallel, commission initiated two proceedings to explore how customers can consume and produce electricity differently

Commission convened public conference to solicit input from stakeholders

Stakeholders included IPPs, utilities, consumer organizations, ISOs and grid-facing organizations

Source: http://www.psc.state.md.us/transforming-marylands-electric-grid-pc44/

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